GUEST WITH A TWIST

Activity Guide

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British Columbia Council, BC Program Committee
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WELCOME

Welcome to GUEST with a Twist, an event presented by the BC Program Committee. This activity guide is designed especially for Guides, and goes along with kits available in April 2023.

GUEST is designed for two meetings or a full-day session. The first part of the activity guide provides instructions for two kit items: bristlebots and LED bracelets. The second part explores a wide variety of hands-on science, technology, engineering, and math (STEM) options. You also received 3 additional activities in the kits (see below).

To complete GUEST with a Twist: Part 1 activities plus 4–5 additional activities.

Check the requirements for each activity, as some suggest extended observation time or taking components home. These can make great 'at-home' extensions, so Guides can report back on what happened. In other cases, a leader can take photos and share them for follow-up discussion.

KIT CONTENTS

- Bristlebot components
- LED bracelet components
- Lung kits*
- Egg Drop kits*
- Kaleidoscopes*
- Stethoscopes*
- Engineering BC items: wooden puzzles, bookmarks, stickers
- GUEST with a Twist crests

Step-by-step instructions for bristlebots and LED bracelets are in Part 1 of this activity guide. Items marked with an asterisk (*) have instructions provided with the kit (and not in this guide). Part 2 of the activity guide presents a wide variety of additional STEM options that your unit can choose.

PART 1: KIT INSTRUCTIONS

BRISTLEBOTS

Source: https://www.sciencebuddies.org/stem-activities/toothbrush-bristlebot

TOTAL PROJECT TIME
30-45 minutes

KEY CONCEPTS
robotics, circuits

MATERIALS

- Coin cell battery
- Vibration motor
- Toothbrush (remove the handle before the meeting)
- Small piece of double-sided foam tape
- Scissors *(not included in the kit)*

Could you build a robot on the head of a toothbrush? It sounds wacky, but bristlebots are tiny, simple robots that buzz around like bugs. They are easy to build and fun to play with. You don't need any previous experience with robotics to make one. You can even build two bristlebots and race them against each other!

INSTRUCTIONS

- Before the meeting, an adult should remove the toothbrush heads using a strong pair of scissors or pliers.
- Follow along with the video to assemble your bristlebot. **Be gentle** with the motor wires. They are thin and can rip if you are not careful. Optional: apply a dab of hot glue at the base of each wire to help reinforce it. *Video*:https://www.youtube.com/watch?v=Q1zToREgV0c&embeds_euri=https%3A%2F%2Fwww.sciencebuddies.org%2F&embeds_origin=https%3A%2F%2Fwww.sciencebuddies.org&feature=emb_imp_woyt
- Follow these troubleshooting tips when using your bristlebot:
    - Do not let the exposed metal parts of the red and black wires touch each other directly. This will create a short circuit and drain the battery very quickly, which will prevents the motor from vibrating.
    - If your robot suddenly stops moving, check to make sure that the wires did not come loose. If the wires are not attached, this creates an open circuit

that prevents the motor from vibrating. If this happens, tightly twist the wires back together.

- If your robot falls over a lot, make sure the motor and battery are centred on top of the toothbrush. You can also let the robot run continuously for 5–10 minutes, and it will slow down slightly as the battery begins to drain.
- To turn your bristlebot off, untwist one set of wires (you don't need to disconnect both). Make sure to turn off your robot when not in use to conserve battery power.

WHAT HAPPENED?

When you connected the motor and battery wires, you created a closed circuit. This causes electricity to flow through the motor. The motor is the same type found in cell phones and video game controllers to make them vibrate. Inside the motor, the electricity makes a tiny weight spin, which causes the entire robot to wobble. This movement makes the bristlebot buzz around the table.

DIGGING DEEPER

When you connect the wires of the battery and motor, you create a circuit. This circuit allows electricity to flow in a loop from the battery, through the red wires to the motor, and through the black/blue wires back to the battery. Electricity needs a closed circuit (a complete loop) to flow. If you only connect one set of wires, the motor will not turn on because the circuit is open. This is why you can turn the bristlebot on and off by disconnecting one set of wires.

The metal wires are conductors, which means they allow electricity to flow. They are coated with coloured plastic (red and black/blue); this plastic is an insulator that does not let electricity flow. It is okay for the insulated plastic parts of the wires to touch each other. However, avoid letting the exposed metal parts of the opposite wires touch, because this can create a short circuit and cause your battery to drain very quickly.

LED BRACELETS

Source: https://www.instructables.com/LED-Cuff-Bracelet/

TOTAL PROJECT TIME
30-45 minutes

KEY CONCEPTS
Circuits, electricity

MATERIALS
- Conductive thread
- Needle threader
- Sewing needle (size 7)
- Battery holder
- CR2032 coin cell battery
- LED
- Sew-in snap (size 3)
- Felt
- Round nose pliers
- Scissors
- Ruler
- Embellishments: felt, beads, buttons, fabric or hot glue, embroidery floss

INSTRUCTIONS

- The LED, battery holder, and battery have polarity. That means there is a positive (+) and negative (–) side to each component.
    - LED: The positive leg of the LED is longer (+, longer). The negative leg is shorter (–, shorter).
    - Battery holder: The positive end of the battery holder looks like an "E" shape (+, "E"). The negative end has a slot (–, with slot).
    - Battery: The top positive side of the battery has writing on it (+, with writing). The bottom negative side is blank (–, blank).
- To test the LED and battery: Touch the LED positive (+, longer) leg to the battery positive (+, with writing) side. See the LED light up! Now touch the LED negative (–, shorter) to the battery positive (+, with writing) side. It won't light up.

- To make your LED sew-able, use pliers to twist the legs into circles. Twist the LED positive (+, longer) leg into a larger loop. Twist the LED negative (–, shorter) leg into a smaller loop.
- Cut the felt so that it fits your wrist, about 5 cm x 20 cm (2 x 8 inches). Before you cut the felt, try it on to check the length of the bracelet. Make sure the length will be enough for your wrist circumference. The bracelet should overlap about 2 cm (1 inch) when worn.
- Lay out your components. Make sure that the LED negative (–, smaller) loop matches the battery negative (–, blank) side. The prong (outie) snap will be sewn on top of the bracelet, nearest you. The hole (innie) snap will be sewn on the bottom of the bracelet, away from you.

Sewing advice: Sew all the parts tightly, with small stitches. Use running stitch (sew in and out). Avoid long stitches: Longer stitches will make your circuit too floppy, and the connection may be bad.

How to Sew the Circuit:

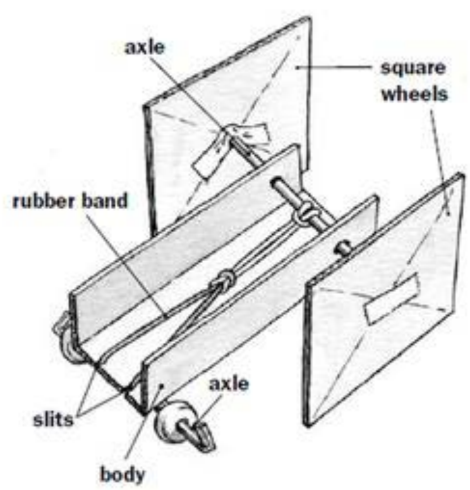
- Start sewing on the top of the bracelet: Thread the needle with conductive thread, and tie a knot in the loose end of the thread, opposite the needle.
- Position the prong (outie) snap on the top of the felt, facing you. Sew it on.
- From prong (outie) snap to LED positive (+, larger) loop: Start sewing with conductive thread at the prong snap and go to the LED positive (+, larger) loop. Sew through the LED positive (+, larger) loop three (3) times. Knot and cut the thread.
- From LED negative loop (–, smaller) to battery holder negative end (–, with slot): Make a new knot on the loose end of the conductive thread, opposite the needle. Start sewing at the LED negative (–, smaller) loop, sewing through the negative loop three (3) times. Then sew from the loop to the battery holder negative (–, with slot) end. Knot and cut the thread.
- Start sewing on the bottom of the bracelet: Make a new knot on the loose end of the conductive thread. Position the hole snap on the back of the felt, away from you. The hole (innie) part should face out so the snap (outie) prong can fit in it. Before sewing the hole snap, test fit the bracelet to find the snap's position. Mark the correct spot on the bracelet, and sew the hole snap in place.
- From battery holder positive end (+, "E") to hole (innie) snap: Start sewing again at the battery holder positive end (+, "E") and go to the hole snap. Sew the hole snap on the back of the felt, away from you. Knot and cut the thread.
- Test out your bracelet! Does it turn on when you snap it together? If not, let's troubleshoot.
    - Do you have thread running across any component?

- The LED positive (+, larger loop) should not be connected to the LED negative (–, smaller loop). If they are, cut the thread and resew each point.
- The battery top (+, with writing) should not be connected to the battery bottom (–, blank). If they are, cut the thread and resew each point.
- Does your circuit flicker? Your stitches may be making intermittent contact. Add some short stitches between components, or sew more stitches to tighten them down.
- Are your components floppy? Add stitches to tighten them down.

PART 2: STEM ACTIVITIES

Choose 4–5 activities to complete the second part of GUEST with a Twist.

ENGINEERING

<table>
<tr><td colspan="2">Cardboard Rover</td></tr>
<tr><td>Source:
https://www.jpl.nasa.gov/edu/learn/project/make-a-cardboard-rover/</td><td><u>Supplies (per rover)</u>
• One 15 cm (6 inch) square of corrugated cardboard (= body)
• Two 13 cm (5 inch) squares of corrugated cardboard (= wheels)
• 1 sharpened round pencil
• 2 rubber bands
• 2 pieces of hard round candy with a hole in the middle (like a Lifesaver)
• 1 plastic drinking straw
• Ruler
• Tape
• Scissors</td></tr>
<tr><td>
</td><td><u>What to do</u>

1. Plan
Look closely at this prototype of a rover like the one you are making. Prototypes are used all the time in engineering. They give you a basic design from which to build, test, and evaluate. Part of the engineering design process involves improving a design based on testing.

Ask yourself these questions:
• How do you make the rover move?
• How would the rover move if it had square wheels?
• How can you improve the wheels?</td></tr>
</table>

2. **Make the rover body**
   Fold the cardboard into thirds along—not across—the corrugated lines inside the cardboard). Push up the sides of the rover body to form a trench. Each section will be about 5 cm (2 inches) across.

3. **Make the rear wheels**
   On the two 13 cm (5 inch) cardboard squares, draw two diagonal lines from the corners to form an X. With a pencil, poke a small hole in the centre where the lines cross.

**Important: Avoid poking yourself accidentally with the pencil. Keep your hands away from where the pencil will go through the cardboard.*

4. **Attach the rear axle and wheels**
   Carefully use a pencil to poke a hole near the top of each of the two outer sections on the rover body. *Again, keep your hands away from where the pencil will go through the cardboard*. Make sure the holes are directly across from each other and big enough for the pencil to spin freely. This is where your axle will go.

   Slide the pencil through the axle holes. Carefully slide the cardboard wheels onto each end of the pencil and secure them with tape.

5. **Make the front axle and wheels**
   Tape the straw across the bottom of the rover body on the opposite side from the pencil. Slip a candy onto each end of the straw. Bend the ends of the axle and tape them to stop the candies from coming off.

6. **Make a rubber band chain**
   Connect the two rubber bands to create a chain as shown in the photos.

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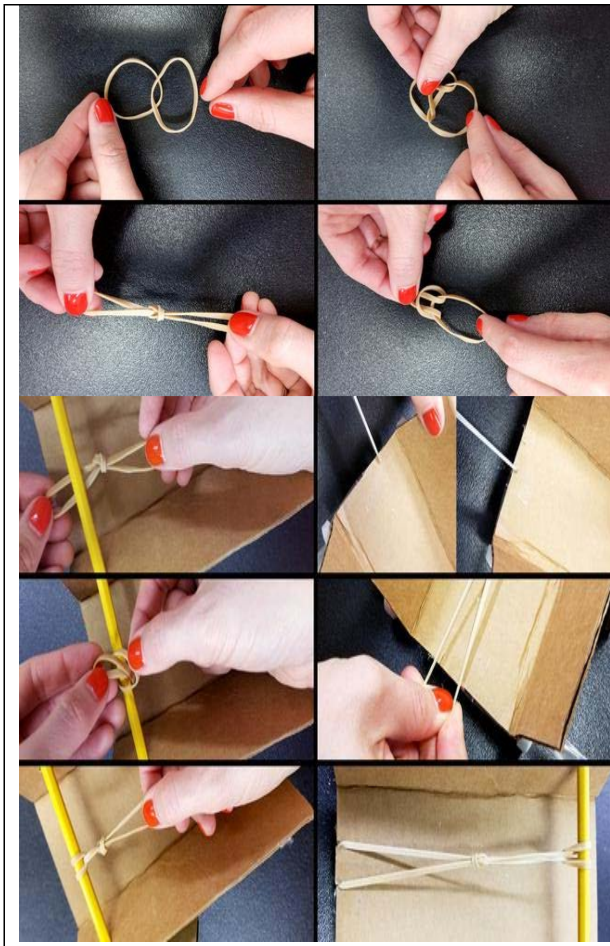
<td></td>
<td>
7. Attach the rubber band
Loop one end of the rubber band chain around the pencil, as shown in the image. Cut small slits into the front end of the rover body. Slide the free end of the rubber band chain into the slits

8. Ready, set…
Turn the back wheels to wind up the rubber band around the axle. This powers up your rover.

9. Put your rover to the test
With the rover on the floor, let go! Observe what the rover does. Measure the distance it travelled.

10. Evaluate the design
Think about how your rover performed and what could be improved:
• Did the wheels turn freely?
• Did the rover travel in a straight line?
• How far did it go?
• Did the wheels spin out without the rover moving much, or did they have traction on the ground and make the rover move?
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Clothespin Airplane	
Source: https://www.steamsational.com/clothespin-airplane-engineering-challenge/	**<u>Supplies</u>** • Wooden clothespins • Jumbo craft sticks (15 cm / 6 inch) • Scissors • Hot glue gun and glue sticks • Acrylic paint • Paintbrushes • Pony beads

	**<u>What to do</u>** Try to build a realistic airplane using clothespins and craft sticks. Pony beads can be used as wheels. Have photos of real airplanes (modern and vintage) for Guides to use for reference. After the airplanes are assembled, paint them as desired. Once dry, launch the airplanes like paper airplanes. Which designs fly the best?

Straw Rocket	
Source: https://www.jpl.nasa.gov/edu/learn/project/make-a-straw-rocket/ Video: https://youtu.be/aTd2f59TSVo	**<u>Supplies (per rocket)</u>** • Pencil • Scissors • Tape • Drinking straw (plastic or reusable) • Meter stick or measuring tape • <u>Rocket template and data log</u> (download)
	**<u>What to do</u>** 1. **Make the rocket body** Carefully cut out the large rectangle on the rocket template. This is be the body of the rocket. Wrap the rocket body lengthwise around a pencil. Tape it closed to form a tube. If you're using a reusable metal straw, check that the rocket body fits around the straw. If it's too narrow, wrap the paper around the metal straw instead of the pencil. The rocket body should be loose enough

	to slide off the straw, but not loose enough to have large gaps between the straw and paper. 2. **Cut out and tape on the fins** Carefully cut out the two fin units. Line up the rectangle in the middle of the fin with the bottom of the rocket body. Tape the first fin to the rocket body. Nothing should stick out past the bottom of the rocket body. Tape the other fin to the rocket body the same way, but on the other side. It should look like a ‘fin sandwich’. 3. **Bend the fins** Bend the triangular part of each fin by 90º so each fin is at a right angle to its neighbour. From the bottom of the rocket, the fins should look like a +. 4. **Make the nose cone** Twist and pinch the top of the rocket body around the tip of the pencil to create a ‘nose cone’. Tape the nose cone to prevent air from escaping and prevent it untwisting. 5. **Prepare for launch** Remove the pencil and replace it with the soda straw. 6. **Three, two, one … launch!** Make sure that your launch area is clear of people and other hazards. Mark your launch point with tape or an object. Then, blow into the straw to launch the rocket! Measure the distance your rocket travelled with a meter stick or measuring tape. Which rocket went the furthest?

Spaghetti Construction

Source: https://www.jpl.nasa.gov/edu/learn/project/building-with-spaghetti/

Supplies (per structure)

- 20 sticks of uncooked, thick spaghetti
- Large marshmallow, crumpled up paper towel, or similar-sized object
- 1 m of tape
- Scissors
- Notebook or paper
- Pencil
- Meter stick or tape measure
- Stopwatch or timer

What to do

1. **Get inspiration from NASA**
   NASA builds giant antennas to talk to satellites and space telescopes across the solar system. These structures form NASA's Deep Space Network. They must support the weight of massive dishes and stand up to strong winds. See what it's like to build a structure that has to withstand the forces of wind and gravity.

2. **Design your structure**
   Your challenge is to use a limited amount of spaghetti and tape to build a structure that can support a marshmallow. Make it as tall as you can in only 18 minutes.

   Get creative and think up ideas for a structure that might support your marshmallow (or an object of similar size and weight). Sketch your ideas.

3. **Let the countdown begin**
   Set a timer for 18 minutes. Start the timer, and begin building your spaghetti structure. Use your design.

	4. **Test your structure** When your structure is complete, test it by putting the marshmallow on top. Will stay it in place for 15 seconds? 5. **Improve your design** If your structure didn't support the marshmallow for 15 seconds, think about the good parts of the design and what could be improved. Redesign and rebuild your structure. If your structure supports the marshmallow for 15 seconds, measure how high the marshmallow sits on your structure. Can you improve your design so the marshmallow sits up higher? At the end of 18 minutes, measure how high your marshmallow is.

Strong Bridges	
Source: https://www.education.com/science-fair/article/strong-bridges/ Project download: https://www.education.com/download-pdf/science-fair/76038/	**Supplies** • Craft sticks • Glue • String • Weights • Bowl of warm water • Wax paper
	What to do Using craft sticks, glue, and string, construct three different types of bridges. Use the same materials in each bridge so you can test the strength of the bridge *design* and not the strength of the bridge materials. 1. **Make a beam bridge** Glue 3 sticks together at the ends to form a triangle. Repeat to make 10

triangles.

2. Glue 4 sticks together in the shape of a square. Make 7 squares.

3. Allow the glue to dry completely on the 10 triangles and 7 squares to dry (check the glue label to find out how long to wait).

4. Place 1 square down flat. Place 2 more squares upright on opposite sides and glue them to the flat square. Allow the top edges of the upright squares to come together and glue them there.

   Repeat to make one more like this, and allow the components to dry.

5. Use 5 triangles to make each side. Place one triangle so that a point faces away from you. Line up the next triangle so a point is facing toward you. Glue these triangles together along one of the craft sticks (they will be side-by-side and slightly overlapping). Continue in this fashion until you have five triangles in a row.

6. Repeat step 6 to make one more row of 5 triangles. Allow the glue to dry completely.

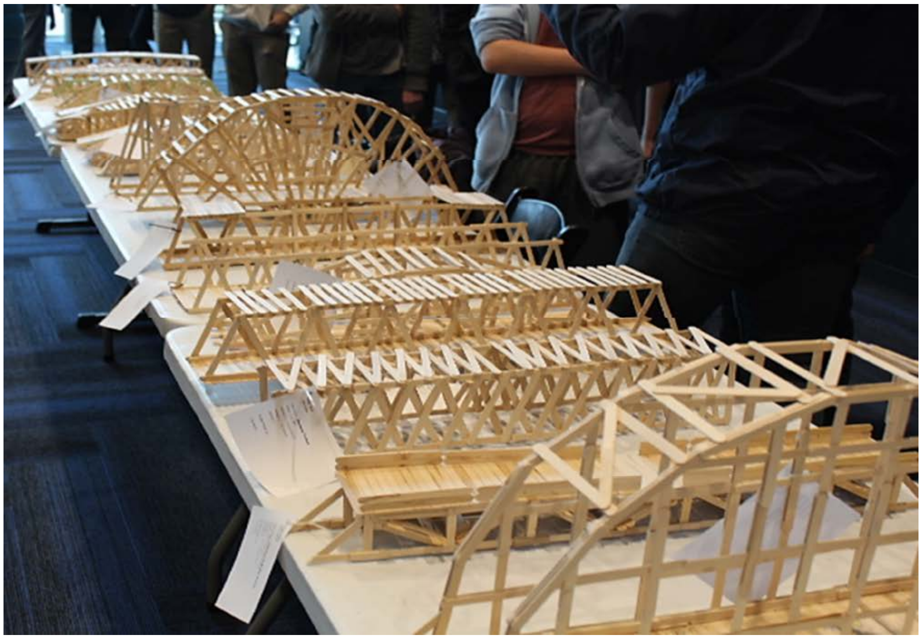
7. Put the last square in the centre of your workspace. Place the 2 structures (made of 3 squares each, step 4) on opposite sides of this flat square. Make sure the edges are touching and glue the seams together. Allow the glue to dry completely.

8. Turn the bridge so that the points on the 3-square structures are facing towards you.

	9. Glue the first side (5-triangle piece) onto the bridge. Allow the glue to dry completely. 10. Turn the bridge over. Glue the second side onto the bridge, making sure the points of the triangles are lined up with the points on the other side. Allow the glue to dry completely. 11. Glue a craft stick between each set of triangle points (there are 3). Allow the glue to dry completely. **12. Construct an arch bridge** Cut the round edges off 76 craft sticks. Now place six trimmed sticks in a bowl of warm water. 13. Glue 16 trimmed craft sticks together into a stack. Repeat to make a second stack of 16 sticks. 14. Glue 17 trimmed craft sticks together into a stack. Repeat to make a second stack of 17. 15. Glue the stacks together in order: 16 sticks–17 sticks–17 sticks–16 sticks. 16. Glue one of the wet sticks onto one side of the top of these stacks. Repeat with another wet stick and glue onto the other side of the stacks. The wet sticks will bend to accommodate the different heights of the stacks. 17. Glue one dry stick to the side of the bottom of the stacks. Now glue another dry stick to the opposite side of the bottom of the stacks. These sticks will remain straight. 18. Attach a dry craft stick to each end of

	both bottom sticks by overlapping them slightly. 19. Use the last 4 wet sticks for this step. Glue one end of each of wet stick to the ends of the sticks on top of the bridge. Connect these sticks to the sticks coming off the bottom of the bridge. You may need to trim the sticks or add additional sticks to make them line up. You should now have an arc from the top of the bridge to the base on each side. 20. Glue craft sticks on top of the edges of the arc, flat side down. 21. **Make a suspension bridge** Place 50 craft sticks together so the long sides are touching on a piece of wax paper. Glue the edges together and allow the glue to dry completely. 22. Make 4 squares using 4 craft sticks each. Glue the sticks together at the corners. Allow the glue to dry completely. 23. Glue 2 sticks together at the ends to create one long craft stick. Repeat this step until you have 16 long sticks. Allow the glue to dry completely. 24. Take 2 long sticks and glue them together so they form a 90º angle. You are making the sticks into a corner. Repeat to make 8 corners. Allow the glue to dry completely. 25. Glue 4 corners upright into the corners of one of the squares (step 22). Glue another square to the corners at the other edge. You should have a tower with a square at each end.

	Make a second tower with 4 corners and 2 squares. Let the glue dry completely. 26. Remove the bridge from the wax paper. Place one tower at either end. Run a string between the 2 towers so that the string sags toward the bridge and almost touches it in the middle. Make sure this string is on the outer edge of the towers and the bridge. Repeat on the other side of the bridge. 27. Tie shorter pieces of string from the long string onto the individual popsicle sticks on the bridge. Start in the middle and work your way out. 28. **Test the strength of your bridges** Place your beam bridge between two tables. Slowly add weight until the bridge collapses. Record how much weight it took to break the bridge. Repeat the test for each bridge.



CHEMISTRY

Floating Stick Man

Source: https://gizmodo.com/the-science-behind-that-stick-figure-doodle-brought-to-1791911033

Video: https://youtu.be/Dm0IcLGQ2HA

Supplies

- Dry erase marker
- Glass or shiny ceramic plate
- Water

What to do

1. With the dry erase marker, draw a stick man on the glass.
2. Very gently, add water to the surface.
3. You should be able to move your stick man around with your finger or by blowing on it.

How It Works

The ink in dry erase markers is insoluble. That means it cannot be dissolved in a liquid. More importantly, it's less dense than water. When you pour water onto a dry erase stick figure drawn on a smooth surface, a strong buoyancy force overcomes the stickiness of the ink. This force pulls the doodle off the surface and makes it float—not so magically—on the water.

Elephant Toothpaste

Source: https://babbledabbledo.com/amazing-science-how-to-make-elephant-toothpaste/

Video: https://youtu.be/cvm9UUaY-sE

Supplies

- Hydrogen peroxide (20 volume or 3%)
- Food colouring
- Very warm water
- Yeast (1 packet or ½ Tbsp per experiment)
- Dish soap
- 2 L recycled plastic water bottles
- Funnel
- Tray
- Measuring cups and spoons
- Safety goggles
- Plastic gloves

SAFETY

- 20 volume hydrogen peroxide is a high concentration and can irritate or burn skin. Only adults should pour peroxide into the bottles.
- All participants should wear safety goggles and plastic gloves at all times during this experiment.
- The bottles can tip easily! Once the hydrogen peroxide is poured into the bottles, please have Guides hold their bottle steady so it does not fall over and spill.
- The foam is HOT! Do not touch the foam until it has cooled. Always keep your gloves on!

What to do

1. Place your bottle in the centre of a tray with sides. There will be a lot of foam and this will help contain the mess. Place a funnel in the bottle neck.

2. Add a few squirts of dish soap to the bottle.

3. Add 120 ml (½ cup, 4 oz.) of hydrogen peroxide to the bottle. Gently swirl to mix.

4. Add in a squeeze of food colouring. Gently swirl to mix.

5. Mix 1 packet (or ½ Tbsp) of yeast with 120 ml (½ cup, 4 oz.) of very warm water. Stir to dissolve. It may be pasty.

6. Pour the yeast mixture through the funnel into the bottle. Give it a quick swirl then step back. BAM!

How It Works

Hydrogen peroxide is a solution that is chemically similar to water but with one additional oxygen atom. Its chemical formula is H_2O_2. When hydrogen peroxide breaks down, it turns into oxygen (O_2) and water (H_2O). Normally this process happens very slowly. But you can make that reaction happen faster. When you add yeast to the hydrogen peroxide, it acts as a catalyst. Yeast is an organism that contains a chemical called catalase, which helps break down hydrogen peroxide. Catalase is present in almost all living things that are exposed to oxygen; it helps them break down naturally occurring hydrogen peroxide.

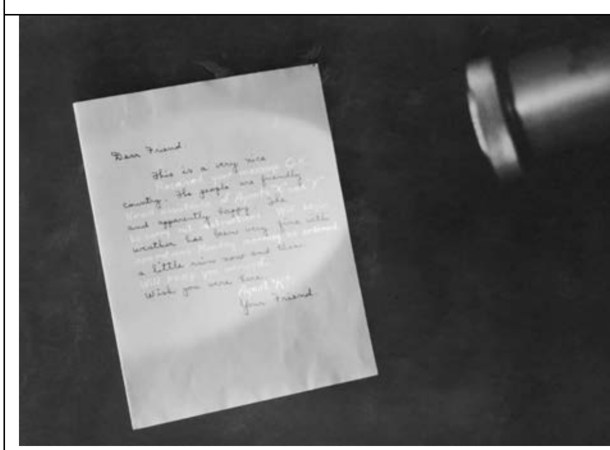
When you mix yeast with hydrogen peroxide, the hydrogen peroxide rapidly breaks down into water and oxygen gas, which forms bubbles. Usually the bubbles would escape from the liquid and pop quickly. But we added dish soap and it provides additional surface tension, so the bubbles get trapped and create lots of foam. This foam looks like a giant squeeze of toothpaste—almost big enough for an elephant! The reaction is exothermic (releases heat), which is why the foam and bottle are hot after the reaction.

Invisible Ink

Source: https://www.thoughtco.com/make-invisible-ink-with-baking-soda-602224

Supplies

- Baking soda
- Paper
- Water
- Measuring cup
- Bowl
- Spoon
- Light bulb (heat source)
- Paintbrushes or cotton swabs
- Purple grape juice (optional)



What to do

1. In a bowl, mix equal parts water and baking soda. Stir until combined.

2. Using a cotton swab, toothpick, or paintbrush to dip into the baking soda solution, write a message on white paper.

3. Let the ‘ink’ dry.

4. Try to read the message. Can you see it on the paper? One way to reveal it is

	to hold the paper up to a heat source, such as a light bulb. You can also heat the paper by ironing it. Heating the baking soda causes it to turn brown, showing the writing on the paper. 5. Another method to reveal the invisible ink is to paint the paper with purple grape juice. The message will appear in a different colour.
How It Works Writing with the baking soda solution disrupts the cellulose fibres in the paper, slightly damaging the surface. When heat is applied, the shorter exposed ends of the fibres darken and burn before the undamaged paper. If you apply too much heat, there's a risk of igniting the paper. Therefore, it's best to apply a gentle, controllable heat source or use the grape juice chemical reaction. Grape juice acts as a pH indicator that changes colour when it reacts with the sodium bicarbonate in baking soda. Sodium bicarbonate is a base and has a high pH.	

Fruit Chemistry	
Source: https://letstalkscience.ca/educational-resources/hands-on-activities/how-can-i-stop-bananas-turning-brown Photo: https://www.thekitchn.com/skills-showdown-how-to-keep-apples-from-browning-23244847	**Supplies** • Lemon juice (1/2 cup per group) • Chewable Vitamin C tablets • Water • Measuring cup • Spoons • Plastic cups (3 per group) • Variety of fruit: apple, banana, peach, pear, etc. (1 type per group) • Knives • Plates (3 per group) • Pastry brushes • Permanent markers
	What to do 1. Label the cups as 1, 2, 3 with the permanent marker. 2. Crush the Vitamin C tablet with the back of a spoon. Place it in cup #1 and add $^{1}/_{2}$ cup of water. Set aside.

3. In cup #2: pour $^{1}/_{2}$ cup of water and set aside. In cup #3: pour $^{1}/_{2}$ cup of lemon juice and set aside. Let all three liquids come to room temperature.

4. Carefully cut up fruit into equally-sized pieces.

5. Quickly place some fruit on three separate plates. Label the plates with the words ‘water’, ‘lemon’, and ‘Vitamin C.’

6. With a pastry brush, paint the cut surfaces of the fruit with water, lemon juice, or the vitamin C—according to the label on the plate.

7. Space the fruit pieces on each plate, so they have lots of space (and air).

8. Wait for 1 hour. Now observe what happened to the fruit on each plate. What do you think the fruit on each plate will look like? Which liquid did the best job at keeping the fruit from turning brown?

9. As a unit, compare the different types of fruit and different solutions.

How It Works

Fruit cells contain many chemicals including aldehydes. When you cut the fruit, many cells are damaged and release aldehydes. When these aldehydes combine with oxygen in the air, they turn brown and change the colour of the cut surface of the fruit. This process is called oxidation.

Vitamin C, also known as ascorbic acid, is found naturally in citrus fruits such as lemons and oranges. It can also be made artificially and used for vitamins and other purposes. The chemical that slows down oxidation in cut fruit is vitamin C, so it’s often added as a food preservative to prevent natural browning. Compounds like vitamin C that slow down the oxidation reaction in cut fruit can also slow down oxidation in living organisms. Oxidation reactions can damage cells, proteins, and other molecules in plants, animals, and people. Getting enough vitamin C can slow or prevent these oxidation reactions.

MATH

M&M Math	
Source: https://www.sciencebuddies.org/science-fair-projects/project-ideas/Math_p021/pure-mathematics/mms-math	**Supplies** • M&Ms – small bags, peanut-free • Graph paper or notebook (optional)
	**What to do** In this experiment, you count the different colours of M&Ms to calculate their frequency. Make a data table like Table 1 (below) to keep track of your data. 1. Open the first package of M&Ms. Count the number of each colour and write the numbers in your data table. No eating! 2. Repeat step 1 for each package of M&Ms. As a group, you should sample at least 5 packages. The more samples you take, the better your data will be. 3. Calculate the total number of M&Ms in each package by adding down each column. Write the number in the Whole Bag box in the bottom row of your data table. 4. For each colour, add up the total number in all the packages combined. Also calculate the total number of M&Ms for all the packages combined. a. Add across each row. b. Write the answers in the Total column of your data table. 5. Calculate the average number of each candy colour per package. Also calculate the average number of

	candies per package. a. Do this by dividing the total numbers you calculated in step 4 by the number of packages (which should be 5 or more). b. Write the answers in the Average column. 6. Calculate the percentage of each colour per package using the average data. a. Divide the average number of each colour (calculated in step 5) by the average number of M&Ms in the whole bag, then multiplying your answer by 100. For example, if there are an average of 5 red M&Ms in each bag, and an average of 50 M&Ms in a whole bag, you should divide 5 by 50 (= 0.10) and then multiply by 100 (which gives 10%). b. Write the answers in the Percentage column. c. Note: If you do this same calculation with your whole bag data, you should get 100%. **7. Make a Bar Graph** Use the data from the Average column of your data table. It tells you the frequency of each colour in the package. It's useful for comparing the frequencies of the different colours. a. Make this graph by hand or using a graphing website. To make the bar graph, label the y-axis (the vertical axis going up and down) with a scale representing the average numbers of M&M's. The smallest number (minimum) will be zero and the largest number of the scale (maximum) will be slightly more than the largest average number of M&Ms in any colour. For example, if the largest average number was

	25 brown M&Ms, make the y-axis scale go up to 30. b. On the x-axis of the bar graph (the horizontal axis going left and right), make a bar for each colour. The height of the bar goes up to the number on the y-axis that corresponds to the average number for that colour. Label each bar with the correct colour (colour the bar with the same colour). Label the bar graph with a title, such as "Average Number of Each M&M Colour in a Package." 8. Looking at your bar graph, try to answer the following questions: • In the average package of M&Ms, which colour are most of the M&Ms (highest frequency)? • Which colour is the rarest (lowest frequency)? • Do any colours have the same frequencies? • Do you see any other trends in your data from the bar graph? 9. **Make a Pie Graph** Use the data from the "Percentage" column of your data table. It tells you how much of the whole bag is of each colour. You can compare the relative proportion of each colour to the whole population of all the M&Ms. a. Make this graph by hand on polar graph paper or using a graphing website. b. Each slice coloured in is equal to the percentage of one of the colours. For example, if blue M&Ms are 15% of a bag, and if your polar graph paper has a slice marked for every 5 units, then colour in three of these slices for the blue M&Ms.

Label each slice with the correct colour. You can even write the percent data inside each slice.

Make a title for your graph, such as "Percentage of Each M&M Colour in a Package."

10. Looking at your data in the pie graph, try to answer the following questions:
    - What is the percentage of each colour in the package?
    - Does any colour make up more than half of a package? What about more than a third of the package?

11. Looking at your data table and graphs, can you predict what colour(s) you are most likely to pick from a package of M&Ms? If so, what colour(s)?

Candy Color	Package					Total	Average	Percentage
	1	2	3	4	5			
Brown								
Blue								
Green								
Yellow								
Orange								
Red								
Whole Bag								

<table>
<tr><td colspan="2">Math Tic-Tac-Toe</td></tr>
<tr><td>Source: https://www.teach-nology.com/worksheets/math/tictac/</td><td><u>Supplies</u>
• Paper
• Pens</td></tr>
<tr><td></td><td><u>What to do</u>

1. Find a partner and gather some paper and 2 pens or pencils.

2. On a piece of paper, draw a 3x3 tic-tac-toe grid. Write the numbers 1 to 9 above or below the grid. This is for tracking numbers that are used. Each number can only be used once.

3. One person is the attacker. The other is the defender. The attacker’s goal is to get a sum of 15 in a line of 3 squares. The defender’s goal is to stop them.

4. The attacker goes first and writes a number from 1–9 in a square. Note: the first number cannot go in the middle square. Cross off this number from the list.

5. The defender goes next and picks a number to block the attacker in the grid.

6. Continue until the attacker makes the sum of 15 OR the defender blocks all their lines.

7. Switch roles and repeat!</td></tr>
</table>

Tangram Races

Source: https://www.tangram-channel.com/

Puzzle template:
https://www.hpl.ca/sites/default/files/Tangram%20Puzzle%20Art.pdf

Supplies

- Tangram template (1 per person)
- Set of puzzle shapes (about 2 per person)
- Scissors

What to do

1. Each Guide will have a tangram template and scissors. Carefully cut out the shapes.
2. Start by introducing a couple of easy shapes, so everyone can practice putting together the pieces (tans) to make a specific pattern.
3. Now Guides can find a partner for the races. Place 3–4 shape cards face down between each pair.
4. When a leader says ‘Go,’ each pair turns over a shape card. The race is on to match the shape with your tan pieces.
5. Once the first shape is complete, the partners can do the next one in the pile.
6. The goal of this game is to have fun creating shapes and getting better at visualizing patterns. You can even invent your own shapes!

How it works

A third-century Chinese mathematician, Liu Hui, is thought to have invented tangram puzzles. He rearranged geometric shapes to explain mathematical facts like the Gougu Rule (also known as Pythagoras’ Theorem). In the 1800s, tangrams became a popular pastime and numerous books of puzzle shapes were published. You can make animals, objects, figures, letters, and much more.

Tangram pieces are geometric, and a complete set includes seven flat polygons. The rules are simple: to make any shape, all the tangram pieces must be used; the pieces must lie flat; the pieces must touch, and no overlapping is allowed. Tangrams are a fun for all ages and build spatial awareness and mental math skills.

Mental Math Games	
Source: https://thirdspacelearning.com/us/blog/math-games-for-grade-5/	**Supplies** No supplies needed
Math, Paper, Scissors **What to do** 1. In pairs, players stand facing each other. 2. Players hold both their hands out in front and call out ‘math, paper, scissors.’ On ‘scissors,’ they hold out any number of fingers (0–10). 3. Both players race to add together their number of fingers plus the number of fingers the other player is holding out. 4. The winner is the first player to call out the total. 5. Too easy using addition? Try subtraction, subtracting the smallest from the biggest number, or multiplication, multiplying the 2 numbers together. 6. Add a third person to make it even more challenging with three digit multiplication, addition, or subtraction.	**Yes - No** **What to do** 1. One player thinks of a number between 0 and 100. 2. The aim for the other player (or play as a whole unit) is to ask questions and work out the number. 3. The questions can only have the answer: ‘yes’ or ‘no’. For example, the number could be 52. Questions could be: Is it an odd number? Is it greater than 30? Can it be divided by 3? etc. 4. The winner is the person who works out the mystery number first. Or with the fewest number of questions asked (if playing in pairs).

PHYSICS

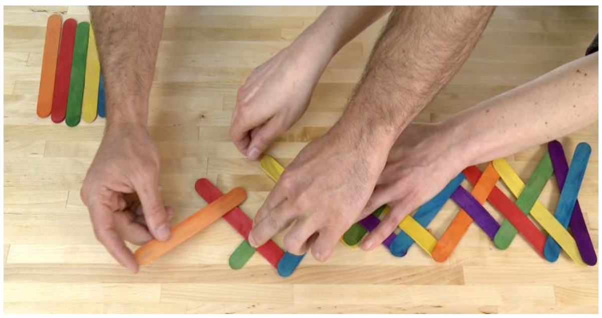
Craft Stick Chain Reaction

Source: https://www.stevespanglerscience.com/lab/experiments/popsicle-stick-chain-reaction/

Video: https://youtu.be/r7j7l39ZAsU

Supplies

- Coloured craft sticks



What to do

1. Lay 2 craft sticks in an X shape on a hard, flat surface. Make sure you have some space. You can move to the floor later for bigger reactions.

2. Take a third stick and place one end under one end of the bottom stick in the X and then over the stick on top of the X. Have a partner keep pressure on the centre of the X while you do this.

3. Repeat Step 2 with a fourth stick. Place it under the open end of the bottom stick and over the third stick. The second and fourth sticks should be parallel to each other. Potential energy is building already and you can probably feel it. Keep applying pressure on the centre. The first X is now locked in place unless your helper lets go.

4. Continue adding craft sticks in this fashion until you have about 10–15 sticks in a chain. Remember that the simple over-and-under design holds it all together, building energy. This pattern is necessary for the experiment to work. Take your time to build up the craft stick tension for the best reaction.

When the chain is as long as you want, let

	go of the end. The craft sticks will jump down the line in a colourful chain reaction.

How It Works

The key to this reaction is potential (stored) energy and kinetic (moving) energy. Twisting and bending the craft sticks creates potential energy in the wood fibres, because they are not in a normal relaxed position. The sticks try to straighten and release the added energy, but because someone is holding them in place. When you let go, all the potential energy is quickly converted into kinetic energy in a chain reaction.

How long a chain can you build? Try moving the craft stick chain onto the floor. Work in teams—who can build the longest chain in a set amount of time?

Leak-Proof Bag

Source: https://pagingfunmums.com/2014/05/25/leak-proof-bag-kids-science-experiment/	**Supplies** • Zip-lock style bags • Sharp pencils • Water
	**What to do** 1. Fill and seal a sealable plastic bags with water. 2. Go outside. 3. Give each person a sharp pencil. One at a time, have them gently stab their pencil through the bag until it pierces both sides. 4. What happens? No water should leak out.

How It Works

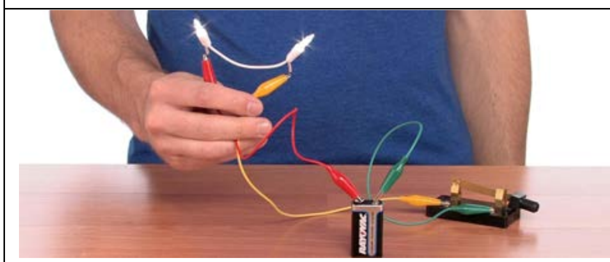
The plastic bag is made of a polymer—long, flexible chains of repeating molecules. When you poke a pencil through the bag, the molecules spread apart and then seal themselves around the pencil.

Build a Circuit

Source: https://www.stevespanglerscience.com/lab/experiments/making-a-circuit/

Supplies

- Used strand of decorative lights
- Wire strippers or scissors
- 9 volt battery
- Knife switch
- Alligator clips



What to do

1. Test the old strand of light. Make sure at least two bulbs in a row are working. Important: unplug the strand. Cut the two lights out of the strand. Try to keep a long piece of wire on both ends of the lights.

2. Use the scissors or wire strippers to remove 13 millimeters ($^1/_2$ inch) of the plastic covering on the wire at each end. The outside covering is called the jacket and is usually flexible and easy to cut. Be gentle so you don't damage the copper wires inside.

3. Make sure the blade on the knife switch is up. Attach an alligator clip to one terminal on the switch. Attach the other end of the alligator clip to a bare copper wire on the light strand.

   Repeat and attach a second alligator clip to the other bare copper wire on the light strand. Are the lights on? Not yet.

4. With the second alligator clip, attach the other end to a silver terminal on the battery.

5. The third alligator clip goes on the other battery terminal and then attaches to the other terminal on the

	knife switch. Are the lights on yet? 6. Close the knife switch. The circuit is now complete and the lights turn on.

How it works

Together, the battery, alligator clips, and light strand make a simple circuit. The battery is the power source. The wires, lights, and switch make a path for the electrons to follow. The electrons start on the negative pole of the battery, then are pushed through the circuit by an electric field to the positive pole. If you build the circuit correctly, the moving electrons do the job of powering the lights.

There are many kinds of batteries, but they all have two terminals and the same purpose—to deliver moving electrons (a current). The battery is designed to convert chemical energy into electrical energy; one terminal has an excess of negative charges, while positive charges come together on the other terminal.

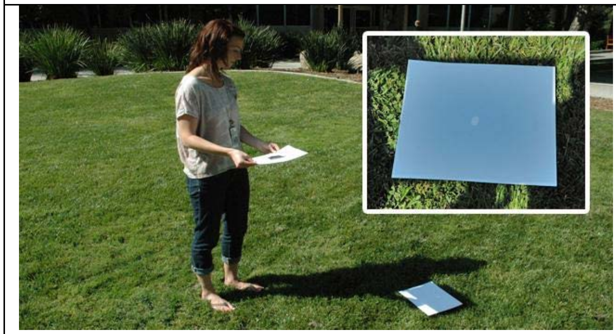
A switch is used to block or allow the movement of electrons in a circuit. It can also redirect electrons into another circuit or device. When the switch is open, the circuit is open and there's no path for the electrons. When the switch is closed, the circuit is closed and electrons can move around and power the lights.

Pinhole Camera

Source: https://www.jpl.nasa.gov/edu/learn/project/how-to-make-a-pinhole-camera/

Supplies

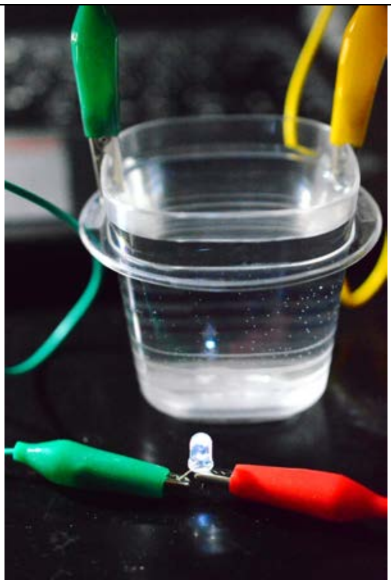
- White cardstock
- Aluminum foil
- Tape
- Pins or paper clips



What to do

1. Cut a square hole in the middle of a piece of cardstock.
2. Tape a piece of foil over the hole.
3. Use a pin or paper clip to poke a small hole in the foil.
4. Place a second piece of cardstock on the ground. Hold the paper with aluminum foil above it, the foil facing up.

	Stand with the sun behind you and view the projected image on the cardstock below. The further away you hold the camera, the bigger your projected image. To make the projection more defined, try putting the bottom piece of cardstock in a shadowed place while you hold the other piece in the sunlight. 5. Try poking holes in the foil to make shapes and patterns.

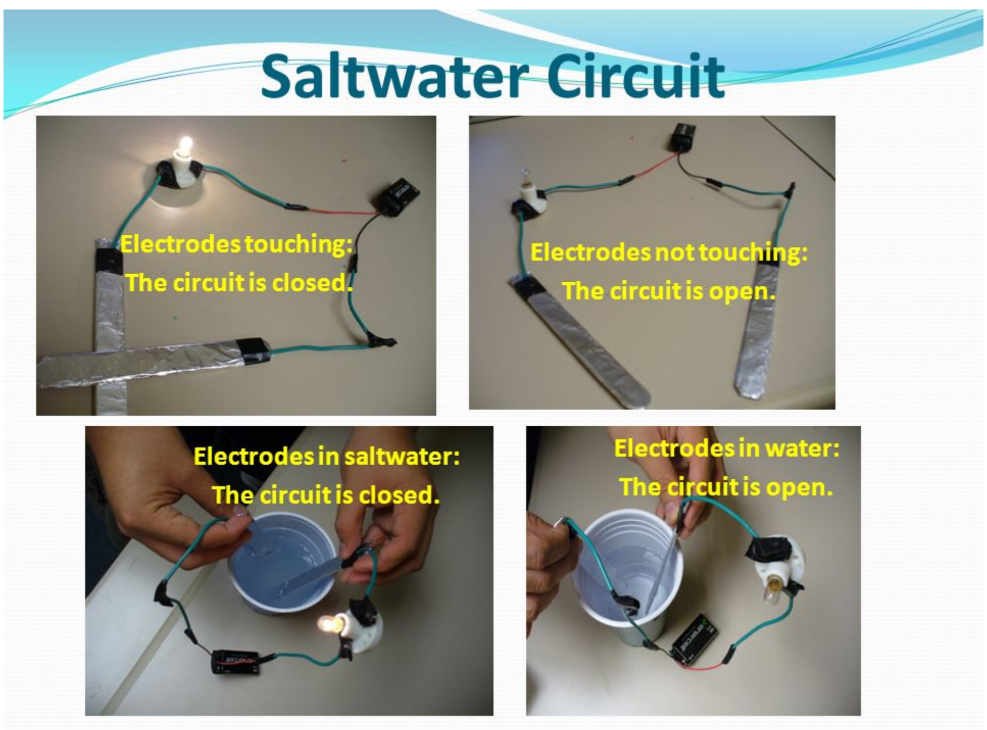
Does Water Conduct Electricity?	
Source: https://www.rookieparenting.com/can-water-conduct-electricity-controlled-experiment/	**Supplies** • Small LED diode • 2 small button batteries • Copper wire or electrical wire with alligator clips • Scotch tape • Tap water • Distilled water • Small container
	**What to do** 1. Fill the small container with tap water. 2. Using the electrical wires, connect the LED light and batteries to make an open simple circuit (a circuit with an open end). 3. Dip the two open ends into the water. Note what happens. 4. Repeat the experiment with the same circuit setup. This time, use

	distilled water instead of tap water. What happens this time. 5. Optional: try a different brand of distilled water and see what happens.

How it works

With tap water, you should be able to complete the circuit, so the LED bulb lights up. However, using distilled water does not complete the circuit, so the LED bulb should not light up. If your light bulb worked with distilled water, it means the "distilled water" was not very pure. Tap water includes impurities, such as dissolved sodium, calcium, and magnesium salts, making it an excellent conductor of electricity. Distilling water is meant to remove impurities like minerals and salts. Completely pure distilled water is H_20 with no free electrons, so it's a poor conductor of electricity.

This activity is also an example of a controlled experiment. This type of test is repeated with exactly the same conditions and variables except for one. The one variable that changes is called an experimental control. Here, water is the experimental control and everything else stays the same, so you can see the effect of water on conductivity in this simple circuit. Comparing tap water and distilled water shows you that the difference in the circuit is caused by the control (water). Tap water can conduct electricity while distilled water cannot.

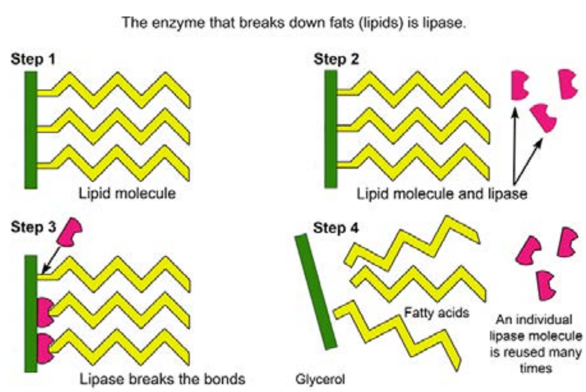


BIOLOGY

<table>
<tr><td colspan="2">Beating Heart</td></tr>
<tr><td>Source:
https://www.growinggradebygrade.com/2015/01/science-watching-beating-heart.html</td><td><u>Supplies</u>
• Marshmallows (regular size)
• Toothpicks
• Paper towel</td></tr>
<tr><td></td><td><u>What to do</u>
1. Push a toothpick halfway into the marshmallow.
2. Put the marshmallow (toothpick up) on the inside of your wrist. You want it to be on the radial artery, which is located on the thumb side of your wrist.
3. Remain calm and quiet.
4. Watch the toothpick. It should wiggle and move with each heartbeat.
5. Count the rate of your heartbeat – how many beats per minute? What happens if someone surprises you? Listen with your stethoscopes.</td></tr>
<tr><td colspan="2">How it works
It takes 20 seconds for blood to travel throughout your body. But your heart beats faster and more often than every 20 seconds—because only some of your blood goes through your heart at one time. Your heart is always pumping to move all the blood around, collecting oxygen in your lungs and moving it to every part of your body.

The faster your body moves, the more oxygen it needs. Your heart has to pump faster to move blood and oxgen to your muscles. Try feeling your heartbeat with a finger on your wrist (no marshmallow needed). Stand still and count the number of beats per minute. Now run on the spot for one minute, stop, and count the number of beats per minute. Lie down for one minute, then count the number of beats per minute. Walk around at a normal pace for one minute and then count the number of beats per minute. When did your heart beat the fastest? How did that feel?</td></tr>
</table>

Digestive System Science	
Source: https://simplesouthern.wordpress.com/2016/01/23/digestive-system-science-experiment-how-does-bile-break-down-fat/	**Supplies** • Milk (at least 2% fat) • Food colouring • Dish soap • Small bowl • Cotton ball
	**What to do** 1. Pour a little milk into a bowl. Put a few drops of food colouring in the milk, placing them far away from each other. 2. Squirt a little dish soap onto a cotton ball. Place it soapy side down in the bowl. You should see the food colouring start to swirl around.
How it works Soap contains a chemical that surrounds the fat in milk and tries to break it into smaller pieces. It does the same thing to dirt, which is why we use it to wash clothes and dishes. As the soap swirls around the fat in the milk, trying to break it down, the food colouring gets moved around too. It will continue to swirl as the soap does its job. This is what happens in your digestive system. Bile, made by your gall bladder, acts like soap to help you digest food. In the small intestine, bile surrounds fat particles and breaks them down. These smaller fat droplets are easier for digestive enzymes (lipases) from the pancreas to process. Bile also help cells absorb these fat droplets in the digestive system.	



Your Genetic Traits

Source:
https://www.education.com/activity/article/Family_Genes_middle/

https://learn.genetics.utah.edu/content/basics/observable

Supplies

- Family genetic traits chart (download)
- Pens or pencils

What to do

1. Each Guide can fill out their genetic characteristics on the chart. Compare the charts and discuss as a unit. What is similar? What is different?

2. After the meeting, Guides take their charts home and interview family members for their information. This works best with more participants—call or email grandparents, aunts, uncles, and other relatives!

   Ask each person about these traits:

- What colour hair do you have?
- Do you get freckles on your face?
- Do you have cheek dimples when you smile?
- Are your earlobes attached or do the lobes hang free?
- Can you roll your tongue up into a tube?
- Are you double-jointed? If so, in what part of your body?

From your results, what traits do you think are inherited from relatives?

How it works

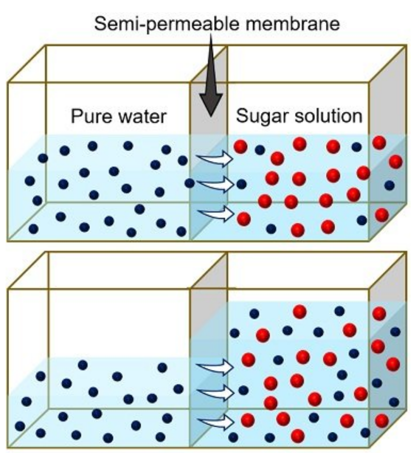
We all have characteristics that we share. However, each person has a unique set of these characteristics. Some are genetic and pass from parent to child, others are acquired through learning. Most traits are a combination of both genes and environmental factors.

Gummy Bear Osmosis	
Source: https://www.homeschool.com/blog/2023/01/homeschool-science-gummy-bear-osmosis/ https://www.evpl.org/posts/simple-science-gummy-bear/	**Supplies** • Gummy bears • Small glasses (6–8) • Baking soda • Sugar • Salt • Carbonated drink or soda • Vinegar • Milk • Paper towels • Kitchen scale (if available) • Ruler • Paper and pen • Timer • Worksheet (download)
	**What to do** 1. Label each glass for a different kind of liquid (tap water, salt water, sugar water, milk, vinegar, etc.). 2. Add ½ cup of water to the tap water glass. 3. Add ½ cup of water plus 1 tablespoon of salt to the saltwater glass. Stir until the salt is dissolved. 4. Add ½ cup of water and 1 tablespoon of sugar to the sugar water glass. Stir until the sugar is dissolved. 5. Add ½ cup of water and 1 tablespoon of baking soda to the baking soda water glass. Stir until the baking soda is dissolved. 6. Add ½ cup of carbonated drink to the soda glass. 7. Add ½ cup of vinegar to the vinegar glass.

	8. Add ½ cup of milk to the milk glass. *Note: Any of these liquids can be omitted or changed according to your preference.* 9. Weigh and measure a gummy bear and record the results. 10. Add one gummy bear to each glass of liquid. 11. Set a timer for 12 hours. 12. After the timer goes off, remove each gummy bear from its solution, weigh, measure, and compare to a new gummy bear. 13. Discuss the results and complete the worksheet.

How it works

Gummy bears contain gelatin, so they don't dissolve in liquid like many other sugary candies. In this experiment, the gelatin in the gummy bear acts like a cell membrane in living cells. The gummy bears get bigger or smaller after soaking in different liquids because of a process called osmosis. Osmosis is the movement of water in or out of a cell's membrane in an attempt to equalize the concentration of molecules. For example in sugar water, water goes into the gummy bear to balance the concentration of sugar (more in the gummy bear), so the bear will swell up. In salt water, water will go out of the gummy bear to balance the concentration of salt (more in the saltwater), causing your gummy bear to shrink. This is the same process that draws water into the roots and stems of plants—or that causes your fingers to wrinkle in the bathtub.



EARTH SCIENCE

Ice and Sea Level Rise

Source:
https://www.jpl.nasa.gov/edu/learn/project/how-melting-ice-causes-sea-level-rise/

Video: https://youtu.be/tYYSndaxl8w

Supplies

- Two identical, clear plastic containers (about 15 cm or 6" square)
- Clay, playdough, or small rocks
- Tray of ice cubes
- Ruler
- Cold water
- Paper or data sheet (download)
- Permanent marker

What to do

This activity can be done in groups or as a unit, but it takes time for the ice to melt. Consider accelerating the ice melt by placing the containers near a lamp or source of mild warmth.

1. **Think about ice**: Where does ice naturally occur on Earth? Make a list of a few places where you might find ice in nature, and sort it into two categories: ice on land and ice in the sea.

   Make a prediction: What type of ice do you think is responsible for sea levels rising? On the data sheet or a piece of paper, write down your prediction about whether land ice or sea ice contributes more.

2. **Set up your experiment**
   a. Press equal amounts of clay into one side of both plastic containers. Make a smooth, flat surface to be land rising out of the ocean. If you don't have clay, use some rocks to create a 'land' surface big enough for several ice cubes.

b. In one container, place as many ice cubes as possible on the flat clay or rock surface. This represents land ice.

c. In the other container, place the same number of ice cubes on the bottom of the container, next to the clay. This represents sea ice.

d. Pour cold water into the sea-ice container until the ice floats. Make sure no ice is resting on the bottom of the container. The water should not be higher than the land level.

e. In the land-ice container, without disturbing the ice cubes on the land, pour water until the water level is equal to the water level in the sea-ice container.

3. Make observations

a. With the ruler, measure the water level (in millimeters) in each container. Record the numbers on your data sheet or paper.

b. Mark the water level. You can do this on the outside of the container, but permanent marker may not come off. You can make a line in the clay using a pencil or other object.

c. At regular intervals—such as every 1 minute or 5 minutes—measure the water level in each container again. Record it on the data sheet. Compare the water level with the marked line on the side of the container or in the clay. Allow the ice in both containers to melt completely.

	d. Use the recorded measurements to create a line graph representing the water level over time in each container. You can do this on paper or on a computer with spreadsheet software (e.g., Excel). • Which container had a greater rise in water level? • How does this compare to your prediction? • Why do you think this occurred? • How is this related to global sea-level rise? • Does the melting of glaciers contribute to sea-level rise? How about the melting of icebergs?

How it works

Sea level is rising because melting glaciers on land add more water to the oceans. Glaciers, which are large sheets of ice and snow, exist year-round on mountains; they are found on every continent except Australia. Both Greenland and Antarctica have giant ice sheets that are considered glaciers. As temperatures rise, glaciers melt faster than they accumulate new snow. When ice sheets and glaciers melt, this water eventually runs into the ocean and causes sea levels to rise.

Icebergs and frozen seawater also melt in warm temperatures but do not contribute much to sea level rise. This is because they are already in the water. The volume of water they displace as ice is roughly equal to the volume of water added when they melt. Therefore, sea level does not rise when sea ice melts.

Another contributor to sea-level rise is the increased volume due to warmer ocean water; this is called thermal expansion. Both thermal expansion and ice melt result from warmer global average temperatures on land and sea, which we know as climate change.

Cloud in a Bottle

Source:
https://www.jpl.nasa.gov/edu/learn/project/make-a-cloud-in-a-bottle/

Supplies

- Clear glass jar
- Warm tap water
- Metal tray or hard-plastic frozen ice pack
- Ice
- Spoon
- Match

What to do

1. **Make water vapour**
Fill a jar with 5 cm (2 inches) of warm water and stir. The warm water forms water vapour through evaporation, which is the process of liquid changing into gas. The water vapour will start to rise inside the jar. However, you cannot see water vapour—it's an invisible gas.

2. **Add smoke particles**
With adult help, light a match, blow it out, and quickly drop it into the jar. The smoke particles provide a surface for the water to condense onto.

3. **Cool the vapour**
Immediately place an ice-filled metal tray or hard-plastic frozen ice pack on top of the jar.

4. **Watch the cloud appear**
Carefully observe inside the jar. A misty cloud should appear near the top of the jar. If you have a hard time seeing the cloud, slightly lift the metal tray or ice pack from one side of the jar and look for wisps of cloud escaping the jar.

5. **Make the cloud disappear**
Remove the metal tray or ice pack. What happens? The cloud disappears.

How it works

The warm water vapour mixes with air and smoke particles. It rises inside the jar and then cools when it comes near the tray of ice. As water vapour cools, it condenses into very tiny droplets on the smoke particles. When enough condensation occurs, we see it as a cloud. When you remove the cold ice tray or pack, the the cold cloud warms up. This makes the condensed water droplets evaporate again, and they turn back into water vapour. This is the same process that creates clouds and rain in the atmosphere, depending on temperature and particles to condense onto.

Tornado in a Bottle

Source: https://coolscienceexperimentshq.com/tornado-in-a-bottle/

Video: https://youtu.be/21b_mIGmJ5w

Supplies

- Empty glass bottle with lid
- 3–4 tablespoons of glitter
- Funnel
- Water

What to do

1. With the funnel, put 3–4 tablespoons of glitter in an empty glass jar. *Tip*: The more glitter you use, the better you can see the tornado.

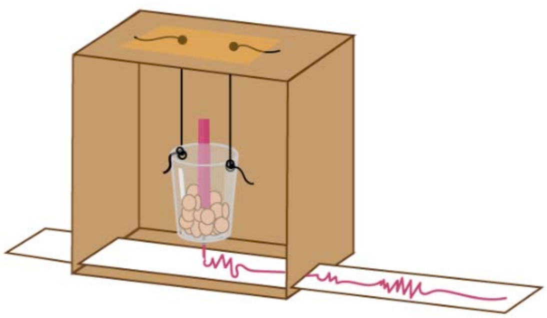
2. Fill the jar about $^{3}/_{4}$ full of water. Put the lid on the jar. Make sure it is very tight.

3. Turn the bottle upsidedown. Quickly move it in a circular motion for 10–15 seconds.

4. Set the bottle down on a table or other fat surface. A ‘tornado’ should have formed. *Tip*: It will take practice to get a clear tornado to form.

How it works

When you swirl the bottle in a circular motion, this creates a water vortex that looks like a tornado. Water spins around the centre of the vortex because of centripetal force, which is an inward force that causes an object to move in a circular path. The glitter in the water helps you see the spinning water more clearly. The glitter particles are similar to dust and debris that gets pulled up and spins around in an actual tornado. A tornado is created by spinning air over land, while a waterspout is spinning air (and water) over water.

Earthquake Detector	
Source: https://letstalkscience.ca/educational-resources/hands-on-activities/how-can-you-build-your-own-seismograph	**<u>Supplies</u>** • Medium-sized cardboard box(es) • Paper/plastic disposable cups • String • Marker • Scissors • Paper cut into long narrow strips • Tape • Coins, marbles, small rocks or other small, heavy weights
	**<u>What to Do</u>** 1. This activity can be done in groups of 2–4 people. 2. Using scissors, carefully cut off the flaps from the cardboard box. Stand the box up on a smaller end. 3. Take your cup. Carefully poke 2 holes opposite each other near the rim of the cup. 4. Tie a piece of string (slightly longer than the length of the box) through each hole in the cup. 5. Now, carefully pole two holes in the top of the box. They should be the same distance apart as the holes in the cup. 6. Push the two pieces of string through the holes in the box. Tie the strings together above the box. The cup should hang down inside the box, with the bottom of the cup suspended 2–3 cm above the bottom of the box. 7. Carefully poke a hole in the centre of the cup's base. Remove the cap from

the marker, and push the marker through the hole—the tip should just barely touch the box.

8. Fill the cup with coins or other small weights. Why do you think the weights are important?

9. Carefully cut two slits on opposite sides of the cardboard box. They should be as close as possible to the bottom of the box. The slits should be wide enough to pass the paper strip through one side, across the middle of the box, and out the other side.

10. Make sure the marker is centred on the paper strip. You might need to poke different holes in the top of the box and re-hang the cup if necessary.

11. Now your seismograph (vibration detector) is ready for testing!

12. Have one person stabilize the box with their hands, while another person slowly pulls the paper strip through the box from side to side. What does the marker draw on the paper strip?

13. Try shaking the box back and forth as your partner continues pulling the paper strip through the box, trying their best to pull at a constant speed. How did the line on the paper strip change?

14. Try pausing your shaking for a few seconds, then shaking the box harder.

15. Try pausing again and shaking the box very gently.

16. Pull the paper strip all the way out of the box and look at the line. Can you tell how hard the box was shaking

	based on the line? Can you tell when the box was not shaking at all? 17. Repeat with more strips of paper as you test out different shaking amounts. Try stomping past the box or jumping up and down.

How it works

When there is no shaking, the marker draws a straight line on the paper. When the box shakes, the paper moves with it. However, the cup is heavy and suspended by strings, so it doesn't move as much as the box; when the paper moves under the (mostly) stationary marker, a squiggly line is left on the paper. The size (amplitude) of these squiggles corresponds to how hard you shake the box. This is how the line drawn by a real seismograph corresponds to the strength of an earthquake.

The Earth's crust is made of large tectonic plates. When these plates slide against each other, they don't move smoothly. With so much friction and pressure between these huge slabs of rock, the movement resembles a series of stick-slip events. It's like going down a water slide with just a little water, so you keep being stuck and have to push yourself forward a little. In plate tectonics, two neighbouring plates get stuck together and pressure builds up. When the pressure becomes greater than the friction force holding them together, the two plates quickly slip past each other, creating a big movement. This 'jump' causes earthquakes, which spread out from the point of movement. Scientists record earthquakes to figure out the boundaries between tectonic plates and how they behave.